BAA Call N00014-23-S-BC14
Special Programs Announcement for Office of Naval Research
Research Opportunity:
Enabling Technologies for Electronic Warfare and Surveillance

I. INTRODUCTION

This announcement describes the technology areas, entitled "Electronic Warfare" and "RF Surveillance" under N00014-23-S-B001, Long Range Broad Agency Announcement for Navy and Marine Corps Science and Technology, which can be found at https://www.nre.navy.mil/work-with-us/funding-opportunities/announcements. The submission of proposals, their evaluation and the placement of research grants and contracts will be carried out as described in the above Long Range Broad Agency Announcement.

The purpose of this announcement is to focus attention of the scientific community on (1) the areas of interest, including advancements in Electronic Warfare (EW), Surveillance, and other associated enabling technologies, (2) encourage dialogue amongst those interested in this area, and (3) the planned timetable for the submission of white papers and full proposals.

II. TOPIC DESCRIPTIONS

To fully enable spectrum superiority, naval forces (including the Marine Corps and Navy) must be able to control the Electromagnetic Spectrum (EMS) by exploiting, deceiving, or denying enemy use of the spectrum while ensuring persistent naval ISR capabilities. The advance of adversary intelligence, surveillance and reconnaissance (ISR) and EW capabilities across the full EMS (DC to daylight), and the proliferation of inexpensive, efficient processors and transceivers has eroded our advantages, created a contested and congested operational environment, and degraded our naval ISR capabilities. This FY24 EW and Surveillance D&I BAA Call seeks innovative solutions to overcome these technical challenges. White papers and subsequent proposals should address technology developments in one or more of the following Research Opportunity Technical Areas 1-6.

Technical Area 1. Wideband RF-Signal Processing Accelerators (EW Focus)

Background: Today's high performance, multi-channel digital transceivers can easily outpace the capacity to perform EW- and ISR-related computations in real-time with current state-of-the-art resources (e.g, FPGAs, GPUs, etc.). This gap forces undesirable tradeoffs for the system designer, especially within platforms with severe size, weight, power and cost (SWaP-C) constraints. This forces designers into limiting sample rates, bandwidth, the number of channels, dynamic range, latency, etc. Additional complicating factors include the bus architecture/overhead required for downstream processing to store, access, and exploit the increased data rates. Companion EW- and ISR-related accelerator chiplets/co-processors are attractive because they could enable applications where agility and ultra-wideband operations are required, such as military communications, radar and electronic warfare.

Objective: Proposals are sought for EW-specific signal processing accelerator chiplets that significantly improve a given figure of merit (FOM) constructed around a notional multi-channel RF processing application given modern direct sampling, large instantaneous bandwidth transceiver capabilities. Proposer's FOM should clearly illustrate the contrast between conventional approaches and the unique aspects of the proposer's accelerator chiplet solution.

For example, multi-resolution, multi-channel Fast Fourier Transforms (MRMCFFT) are attractive for applications where agility and ultra-wideband operation are required. These transforms permit the time-space-frequency analysis of complex spectral content at multiple resolution scales. However, multi-resolution, multi-channel, FFT's significantly stress current FPGA resources, or require larger power-hungry GPUs to enable real-time computations for these transceivers, which isn't compatible with SWaP constrained platforms.

It is also desired that any proposed accelerator chiplet will have an architecture that allows for multiple use cases, and possibly even share memory, or another type of interface, with a conventional CPU/GPU processor and/or another spectrum warfare accelerator chiplet. Notional complementary post-processing might include accumulation of FFTs over time (e.g., creation of multi-resolution spectrograms), filtering, trigonometric operations, logical comparison, matrix multiplication, etc. It is not necessary for the proposed accelerator chiplet to perform complementary processing, but it desired for the architecture to enable it in the future.

Although we refer above to an accelerator chiplet, we recognize that other mature forms of integration may offer performance advantages or reduce risk/cost. For example, process-compatible spectrum warfare IP cores may be consolidated into a single ASIC rather than separated into individual chiplets or die, reducing interconnect overhead. Or the IP may be integrated into an existing FPGA for prototyping. However, any proposed solutions have to demonstrate how their proposed FOM significantly improves over the current state-of-the-art.

Finally, scalable chiplet approaches are desired that would permit subsequent application-specific adaptations of the proposed accelerator IP. For example, it may be desirable to deploy a common accelerator IP architecture that can be optimized at multiple hardware SWaP-C points. If possible, proposers should clearly convey a methodology using COTS, or project-developed tools, to automate the generation of IP scaled to meet higher-level system constraints.

In summary, new technology (hardware / software / firmware / knowledge) solutions are sought which:

1.) Significantly improve upon an EW relevant signal processing Figure of Merit in comparison with state-of-the-art approaches for modern multi-channel transceivers;
2.) Improve or enable complementary pre-/post-processing required for spectrum warfare applications;
3.) Are scalable using an automated toolchain to meet higher-level system constraints;
4.) Are at an early Technology Readiness Level (TRL), suitable for:
    a. Initial 'model scale' prototyping & evaluation using a combination of commercially available hardware (e.g., existing FPGAs) and software simulation.
    b. Subsequent adaptation for 'full-scale' ASIC implementation as either a pure IP core, a standalone chip/die, or a chiplet/die intended for heterogeneous integration.

Note: accelerator chiplet concepts that improve the performance of key aspects of generalized spectrum warfare processing pipelines are welcomed. In order to be considered responsive, proposals must adequately articulate the context and significant Figure of Merit improvement relevant to their submission in similar fashion to the specific MRMCFFT guidance given above. Photonic processing solutions are not desired under this topic.

Technical Area 2. Enabling Survivable Wideband RF Operations (EW and RF Surveillance Focus)

Background: Historically, digital receivers have been narrowband due to analog-to-digital converter (ADC) bandwidth limitations. For these narrowband systems, pre-planned exquisite filtering at an intermediate frequency (IF) was used to prevent unwanted signals from reaching the ADC. In the last decade, however, ADC technology has achieved full-power bandwidths greater than 20 GHz and instantaneous bandwidths of 2-20 GHz with 8-12 effective number of bits (ENOB). Despite these advances, the data converters must still be protected from the effects of co-site interference, self-interference, and adversarial jamming. This technical area seeks to address these challenges through the development of wideband, high dynamic range, high linearity analog filter technologies and novel simultaneous transmit and receive (STAR) techniques for large IBW systems in dynamic multipath environments.

Objective: Proposed solutions should address large bandwidth requirements in support of modern RF and EW operations where spectrum is congested, contested, shared, and dynamically assigned. Proposals should focus on addressing one or multiple challenge areas under this category including:

- System-on-Chip Compatible, High Power, High Linearity, Analog Cancellation Components;
- Adaptive, wideband, tunable filter solutions;
- Digital/Analog STAR technologies to address fast, dynamic multipath environments (e.g., rotorcraft).

General technology requirements:

- Solutions should cover a large operating bandwidth, from S-band through Ka-band frequencies;
- Solutions should enable instantaneous bandwidth of 1 GHz (threshold) to 4 GHz (objective);
- Operation under high transmit power – need enough dynamic range for EW applications (threshold) and radar applications (objective) when operating near 100-watt (threshold) to 250-watt (objective) transmitters.
- Compact demonstrators are desired – topic seeks compatibility with modern RF SoC packaging, 2.5/3D integration approaches, and/or low-SWaP RF cards (e.g., 3U or 6U VPX);
- It is desired that solutions could ultimately be packaged in a Sensor Open Systems Architecture (SOSA) standards and/or Command, Control, Communications, Computers,

Intelligence, Surveillance, and Reconnaissance/EW Modular Open Suite of Standards (CMOSS) compatible form factor.

Technical Area 3. Novel spectrum warfare applications of electromagnetic field interactions in electronics (EW Focus)

Background: Electronic devices of all types exhibit intrinsic nonlinear sensitivity to conducted or radiated electromagnetic waves as well as ionizing radiation. Depending on the design application, device behaviors may not be well characterized outside of the nominal operating point. In electronic subsystems and systems operating in a spectrum warfare environment, interactions might manifest in unintended responses, such as spurious emissions or erroneous operation, that are characteristic to a system's design, construction, operational mode, and environment.

Objective: Novel basic and applied research concepts are sought that seek to improve foundational understanding of unintended electromagnetic interactions as well as the ability to exploit (or suppress) them in future spectrum warfare applications.

Basic research efforts under this topic might lead to novel approaches for efficient and robust modeling, simulation, or characterization of these behaviors, new theoretical analyses that establish boundaries of feasible operation, or new standards for qualification of equipment.

Applied research efforts under this topic might demonstrate the feasibility of new techniques that enable (or prevent): the remote detection, identification, localization, or characterization of individual electronic systems, the disruption or degradation of electronic system operation, and the transfer of information.

Technical Area 4. Low-Cost Technologies to Achieve Phased-Array-Like Performance (RF Surveillance Focus)

Background: Phased array antennas provide a considerable amount of flexibility in forming desired radiation patterns, allowing systems to tailor the direction of received or transmitted microwave energy. However, typical active electronically scanned arrays (AESAs), common throughout military radar and EW systems, come at a high cost per element for that increased flexible pattern control.

There are interesting and viable lower-cost methods for electronically controlling antenna patterns, especially when the system is only a transmitter. Reflectarrays and transmitarrays provide a surface to locally adjust the phase of back-scattered or forward-scattered incident energy, which forms a directed beam of the scattered energy. In recent works, these arrays have a limited number of phase states per scattering cell, which raises the severity of quantization lobes. This is often an acceptable trade for a lower cost system, yet there is interest in pushing for more phase states for better null and sidelobe control in some naval applications.

Graded-index structures can also provide a low-cost means for controlling radiation patterns by forming lensing structures. The Luneburg lens is a classic example. Additive manufacturing processes now enable the fabrication of structures with spatially varying average permittivity. With

the combination additive manufacturing and transformation optics, arbitrary graded-index lensing (GRIN) structures are easier to achieve. Radiation patterns are often adjusted via mechanical means. However, there is interest applying electronic controls through switching or other means of fast adaptation the feed network for a GRIN lens aperture.

Lastly, novel low-loss and high-power microwave switching components are increasingly available, such as wide bandgap PiN diodes, novel structures for high-electron-mobility transistors (HEMT), and photoconductive solid-state switches (PCSS). These are potential enablers for high power microwave phase shifters, filters, multiplexers, or other fundamental elements of a low-cost electronically scanned transmit array.

Objective: This topic area seeks technology that enables electronic antenna pattern control for phased-array-like performance at a significantly reduced cost. Candidate technologies for transmit pattern control are of primary interest – proposed solutions may be transmit-only. However, full transceiver architectures are still of interest and proposed solutions should address potential implementation of a receive mode, if the concept supports it. Proposed efforts shall culminate in a demonstration array and tested at a transmit power that adequately stresses the design, with consideration of cost and availability of high-power microwave sources for testing.

General technology requirements: The following are some guiding requirements. As with many research and development efforts, there is trade space in all of these criteria:

- Operating frequency: One octave between 2 to 12 GHz (T); one decade between 1-20 GHz (O)
- Instantaneous bandwidth: 500 MHz (T), 4 GHz (O)
- Power density of aperture: 15 W/cm^2 (T), 45 W/cm^2 (O)
- Duty cycle: Key mechanism for shaping and directing radiation pattern shall handle CW, although high power microwave source for the Scaled High Power Demonstrator may be pulsed.
- Scanning: Concepts should support beam scanning to +/- 45 degrees without significant scan loss.
- Minimum aperture area for demonstrator: $4\lambda^2$

Other guidance and metrics:

- Both aperture transmit power density versus cost, and effective isotropic radiated power (EIRP) versus cost, are most important.
- Sidelobe and null control: An ability to form nulls in arbitrary directions is important.
- Efficiency: Concepts should address mechanisms for improving overall system efficiency.
- Scalability is important but not critical
- Multisource operation: There is interest in designs that can form multiple beams in multiple directions with different signal content.
- Primary microwave source: Proposals should discuss ROM costs for either renting or acquiring the primary high-power source for a final demonstration. There is potential for government furnished equipment (GFE) sources but no guarantees at this time.

Phasing:

- Base (Component/Subsystem development and demonstration): Proposals should plan for an initial design phase (12 months), followed by detailed design and fabrication (approx. 18 months)
- Option (Scaled High Power Demonstrator): Proposals are encouraged but not required to include an option for building a larger scale demonstrator. This could be in the form of a ROM for a larger version of the main demonstrator, or a follow-on option to build a secondary large version of the array concept.

Technical Area 5. Tunable Surfaces for Dynamic Infrared Beam Control (Surveillance and EW Focus)

Background: The electro-optic and infrared (EO/IR) bands are key for generating high-resolution imagery and for long range sensing. It is also widely used in combination with active emitters such as for laser range finders (LRF), standoff chemical and explosive detection, LiDAR, and communications. All of which require precise beam control across a 2-D plane and with varying input wavelengths. Current methods for beam control in the mid-wave infrared (MWIR) usually involve mechanical beam steering or involve spatial light modulators (SLM) with limited instantaneous bandwidth and lack dynamic tunability.

Objective: This effort seeks novel non-mechanical methods in the MWIR to support beam steering and imaging in this band. Proposals should focus on addressing one or multiple challenge areas under this category including:

- Dynamic tunability of center wavelength over the entire MWIR band.
- Improved beam control: Increasing steering speed, improved field of view, phase control, increasing the instantaneous infrared bandwidth (Objective: full MWIR band).
- Dynamic beam profile control: Wave-front shaping and focusing.

General technology requirements: Proposals should identify within their proposal these key attributes and offer comparisons against the current state-of-the-art (SOA):

- Instantaneous infrared bandwidth and center wavelength.
- 2-D resolution (i.e. pixel count) and fill factor.
- Input acceptance angle (i.e. F/#)
- Optical loss in MWIR for on and off states or can be expressed in terms of IR contrast (dB)
- Operating temperature ranges.
- Polarization.

Technical Area 6: Technologies for Innovative Wideband Distributed EW (EW Focus)

Background: This Call has targeted specific challenges that have been identified in realizing a future vision of Electronic Warfare and ISR where our forces can operate freely within a complex, congested, and rapidly changing EMS. While the focus of this Call is on the preceding five technical areas, ONR recognizes that discovery and innovation can arise in unexpected ways.

Technical Area 6 allows a pathway to consider those concepts that do not fit neatly into Technical Areas 1-5 but offer truly transcendent advances in capability that push forward the vision for the future of EW.

Objective: Technical Area 6 is open to explore additional innovative EW concepts that would fundamentally transform the Navy's current EW capabilities (attack, support, protection).

In order to allow for diverse possibilities but limit responses to truly revolutionary ideas, TA6 proposed efforts should quantitatively describe how the proposed effort would realize a figure of merit (FoM) increase of 1000X over state of the art. In order to arrive at this FoM, proposers should quantify the benefits of their technology over existing technology. Individual FoMs of a concept may be combined/multiplied. For example, a conceptual multichannel, distributed receiver system-of-systems that provides 10 dB more dynamic range, 10x more beam-bandwidth, and 10x more instantaneous signal bandwidth would be responsive to this technical area.

Proposed efforts that do not quantify this 1000X benefit of their approach will be considered non-responsive.

III. WORKSHOPS, INDUSTRY DAYS, WEBINARS

ONR will not hold any workshops, industry days, or webinars related to this BAA call.

IV. WHITE PAPER SUBMISSION

Although not required, white papers are strongly encouraged for all offerors seeking funding. Each white paper will be evaluated by the Government to determine whether the proposed technology advancement appears to be of "particular value" to the Department of the Navy. Initial Government evaluations and feedback will be issued via email notification from the Technical Point of Contact. Whitepapers that are deemed to be of "particular value" to the government will be invited to provide an oral presentation as described in Section V below.

White papers should ***not exceed*** 5 single-sided pages, exclusive of cover page, references, and resume of principal investigator, and should be in 12-point Times New Roman font with margins not less than one inch. White papers shall be in Adobe PDF format (preferred) or in Microsoft Word format.

The ***no more than*** 5-page body of white paper should include the principal investigator's plan to address a specific problem set(s) associated with a topic(s) described in Section II, Topic Description by providing the following information:

- **Technical Concept** – A description of the technology innovation and technical risk areas.
- **Future Naval Relevance (where applicable)** – A description of potential Naval relevance and contributions of the effort to the agency's specific mission.
- **Operational Naval Concept (where applicable)** – A description of the project objectives, the concept of operation for the new capabilities to be delivered, and the expected operational performance improvements.

- **Operational Utility Assessment Plan (where applicable)** – A plan for demonstrating and evaluating the operational effectiveness of the offeror's proposed products or processes in field experiments and/or tests in a simulated environment.
- **Rough Order of Magnitude (ROM)** cost estimate.

A resume of the principal investigator, not to exceed one (1) page, should also be included after the body of the white paper.

To ensure full, timely consideration for funding, white papers should be submitted **no later than (NLT) 11 Aug 2023 1600 EST**. White papers received after that date will be considered as time and availability of funding permit.

The planned date for completing the review of white papers is **25 AUG 2023**.

V. ORAL PRESENTATIONS

ONR requests that Project Managers (PMs)/Principal Investigators (PIs) provide an expanded oral presentation from those Offerors whose proposed technologies have been identified as being of "particular value" to ONR. The purpose of the oral presentation is to provide greater detail than can be contained in the White Paper and to permit the evaluation panel to ask questions to better understand particular aspects of the proposed effort. However, any such request does not assure a subsequent award. Any Offeror whose White Paper technology was not identified as being of "particular value" to ONR will not be invited to make an oral presentation. The requested oral presentations will occur on, or around, 11-14 SEP 2023. The time, location, and briefing format of the oral presentations, if requested, will be provided at a later date via email notification.

ONR evaluations of the oral presentations will be issued via email notification on or about 21 SEP 2023.

VI. FULL PROPOSAL SUBMISSION AND AWARD INFORMATION

Detailed full proposal (Technical and Cost volumes) will be subsequently encouraged from those offerors whose proposed technologies have been identified through the above referenced email as being of "particular value" to the government. However, any such encouragement does not assure a subsequent award. Full proposals may also be submitted by any offeror whose white paper was not identified as being of particular value to the government or any offeror who did not submit a white paper.

For proposed efforts that are considered of particular value to the Navy, but either exceed available budgets or contain certain tasks or applications that are not desired by the Navy, ONR may suggest a full proposal with reduced effort to fit within expected available budgets or an effort that refocuses the tasks or application of the technology to maximize the benefit of the Navy.

Full proposals should be submitted under N00014-23-S-B001 by **27 OCT 2023.** Full Proposals received after that date will be considered as time and availability of funding permit.

ONR anticipates that both grants and contracts will be issued for this effort.

Full proposals for contracts should be submitted in accordance with the BAA instructions at Section IV, Application and Submission Information, item 2.b, Full Proposals and item 6, Submission of Full Proposals for Contracts, Cooperative Agreements, and Other Transactions.

Technical Proposal/Content shall be single spaced and not exceed 15 pages. The cover page, resumes, bibliographies, and table of contents are excluded from the page count. For contract proposal submission, all submissions should be submitted electronically per section VIII unless submitting a classified proposal. Classified submissions can be mailed.

Full proposals for grants should be submitted in accordance with the instructions at BAA Section IV, Application and Submission Information, item 5, Submission of Grant Proposals through Grants.gov. All full proposals for grants must be submitted through www.grants.gov. The following information must be completed as follows in the SF 424 to ensure that the application is directed to the correct individual for review: Block 4a, Federal Identifier: Enter N00014; Block 4b, Agency Routing Number, Enter the three (3) digit Program Office Code 312) and the Program Officer's name, last name first, in brackets (Green). All attachments to the application should also include this identifier to ensure the proposal and its attachments are received by the appropriate Program Office.

ONR plans to allocate approximately $15-20M dollars for efforts related to the Technical Areas in this Call. The period of performance for projects will be one to three (1-3) years. Proposed multi-year efforts are requested to be structured with a base effort of 1 year, followed by option years pursuant to a program review on an annual basis. It is anticipated that multiple awards will be made in Technical Areas 1-6 based on the quality of the proposed efforts. White papers are strongly encouraged from all offerors seeking funding.

Although ONR expects the above described program plan to be executed, ONR reserves the right to make changes according to program priorities and funding availability.

Selected proposers will be notified by NOV 2023. Selected projects will have an estimated award date of Q2FY24.

VII. SIGNIFICANT DATES AND TIMES

Event	Date	Time
Recommended White Paper Submission Date	NLT 11 AUG 2023	1600 EST
Notification of White Paper Evaluation	NLT 25 AUG 2023	
Anticipated Oral Presentation Dates	NLT 11-14 SEP 2023	
Notification of Oral Presentation Evaluation	NLT 21 SEP 2023	
Recommended Full Proposal Submission	NLT 27 OCT 2023	1600 EST
Notification of Selection Full Proposals	NLT 03 NOV 2023	
Awards	NLT Q2FY24	

VIII. POINTS OF CONTACT

In addition to the points of contact listed in N00014-23-S-B001 the specific points of contact for this announcement are listed below:

Technical Points of Contact:

Dr. Kevin Leonard
Director, Electronic Sensors and Networks Division
kevin.r.leonard1.civ@us.navy.mil

Dr. Trevor Snow
RF Surveillance Program Officer
trevor.m.snow3.civ@us.navy.mil

Please also copy:

Dr. Jerry Kim, Senior EW Specialist, Contractor Support, jerry.t.kim.ctr@us.navy.mil
Mr. John Luca, Program Analyst Contractor Support, john.t.luca.ctr@us.navy.mil

Business Point of Contact:

Mr. Stephen Hughes
Contracting Officer
stephen.t.hughes.civ@us.navy.mil

IX. ADDRESS FOR THE SUBMISSION OF WHITE PAPERS AND FULL PROPOSALS FOR CONTRACTS

White Papers/Full Proposal:

Unclassified white papers and full proposals should be submitted electronically within FEDCONNECT with copy to jerry.t.kim.ctr@us.navy.mil and john.t.luca.ctr@us.navy.mil by 4:00PM EST on 11 AUG 2023 (white paper) and 03 NOV 2023 (full proposals). Files exceeding 10MB in size should not be emailed, but instead transmitted via a file transfer service, for example DoD SAFE, https://safe.apps.mil. If you will be using DoD SAFE, please request a Drop-Off link from Mr. John Luca, john.t.luca.ctr@us.navy.mil, at least 7 days prior to the submission deadline.

Classified White Papers/ Full Proposals:

Classified white papers and proposals up to the general service (GENSER) Secret level should be mailed via traceable means, with the outer envelope addressed to the Office of Naval Research, Attn: Document Control Unit, ONR Code 43, 875 N. Randolph St., Arlington, VA 22203-1995. The inside envelope should indicate the classification level and be addressed as: Office of Naval Research, Attn: Dr. Kevin Leonard, ONR Code 312, 875 N. Randolph St., Arlington, VA 22203-1995. If you will be mailing a classified white paper or proposal, please send Mr. Luca, john.t.luca.ctr@us.navy.mil, an unclassified email to notify him of your submission.

X. SUBMISSION OF QUESTIONS

Any questions regarding this announcement must be provided to the Technical Points of Contact

and/or the Business Point of Contact listed above. All questions shall be submitted in writing by electronic mail.

Answers to questions submitted in response to this BAA Call will be addressed in the form of an Amendment and will be posted to the following web pages:

- SAM.GOV Webpage – Contract Opportunities (https://sam.gov/content/home)
- FEDCONNECT.NET Webpage – (https://www.fedconnect.net/FedConnect/Default.htm)
- GRANT.GOV Webpage – https://www.grants.gov/
- ONR BAAs, FOAs and Special Program Announcement WebPage https://www.nre.navy.mil/work-with-us/funding-opportunities/announcements

Questions regarding **white papers or full proposals** should be submitted NLT two weeks before the dates as ascribed in Section VII. Questions after this date may not be answered.